

# Medicinal plants with cholesterol-lowering effect marketed in the Buenos Aires-La Plata conurbation, Argentina: An Urban Ethnobotany study

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## ABSTRACT

This contribution presents 82 species of medicinal plants whose products are sold and consumed as cholesterol-lowering in the Buenos Aires-La Plata conurbation, Argentina. The hypocholesterolemic effect is relevant because the high level of blood cholesterol is one of the major risk factors for cardiovascular diseases, leading causes of death and disability almost worldwide. The species were selected from their *locally assigned use*, obtained from interviews with informants, data labels, prospectus and leaflets of products, and information diffused in the media, specially the Internet. Furthermore, a bibliographic review on scientific studies that validate the biological activity and effects of each species was accomplished. The theoretical framework of this research argues that urban botanical knowledge comprising some knowledge *linked to traditions* of various immigrants segments (*invisible* to most of the local population), and other *non-traditional* knowledge (*visible*). The assessment of these kinds of knowledge is approached from the plant products circulation in the restricted circuits of immigrants (Bolivian and Chinese for this contribution) and the general commercial circuit, so that products that pass from the first circuit to the second gain *visibility*. The circulation of plant products that acquire visibility also expressed the botanical knowledge transmission from one context to another, a transmission enhanced and accelerated by the media. In this framework, the visibility levels of plant products considered hypocholesterolemic in the study area are discussed.

**Keywords:** Multicultural contexts, methodological approach, plants and knowledge visibility, botanical knowledge transmission

## INTRODUCTION

This contribution is framed in a research line in Urban Ethnobotany of the Laboratorio de Etnobotánica y Botánica Aplicada (LEBA). This research line argues that botanical knowledge (BK) in multicultural urban contexts is a set of knowledge and beliefs about different plant elements of the environment (plants, parts parts thereof, and derived products). This urban BK contains two qualities of knowledge that interact

in several ways: 1) *non-traditional* (taught and disseminated knowledge, including the scientific knowledge), and 2) *linked to traditions* (the origin traditions of various immigrant groups, local longstanding family traditions). Urban BK orients selection and use strategies of plant products, which are evidenced in the dynamics of their diffusion inside the commercial circuits. Thus, in assessing the circulation of products is possible to rebuild the BK that orients those

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strategies. This is a methodological proposal that the research line of the LEBA has been developing for over a decade in the Buenos Aires-La Plata conurbation, Argentina (Hurrell 2014; Hurrell and Pochettino 2014).

Immigrants from different origin and residence time incorporate to the urban areas both new plant elements as the knowledge about these. Some of the plant elements persist inside the restricted commercial circuit of each group of immigrants, and remain *invisible* to the majority of local population (knowledge *linked to traditions*). Other plant elements enter to the general commercial circuit and become *visible* (*non-traditional* knowledge). The passage from the restricted circuit of immigrants to the general commercial circuit is considered a visualization process in which the uses of plants change their meaning according to the change of context: the meaning of some uses change, new meanings are added (Hurrell 2014). In the visualization process different agents are involved, such as natural products stores locally called *dietéticas* (specialized in selling healthy foods, nutraceuticals, phytotherapies, dietary supplements), and also the mass media (mainly the Internet), which enhance the BK transmission rapidly and in multiple directions (Pochettino and Hurrell 2013; Hurrell et al. 2015).

This paper focuses on medicinal plants products consumed as cholesterol-lowering agents in the study area. This selection is based on the wide dissemination of information (knowledge), especially through the media, in relation to reducing the risk of cardiovascular diseases that involves the use of hypocholesterolemic agents. The relevance of these agents in urban areas is reflected in the wide variety of plant products marketed for that purpose.

*Hypercholesterolemia* is an increase in the normal concentration of cholesterol in the blood, and is one of the major risk factors for cardiovascular diseases such as atherosclerosis, stroke, and myocardial infarction, leading causes of death and disability almost worldwide (Deng 2009). Maintaining cholesterol homeostasis involves various regulatory mechanisms

associated with its synthesis, absorption, metabolism, elimination. Hypercholesterolemia is a mismatch metabolic resulting from those processes. The *hypocholesterolemic* agents reduce the high cholesterol levels, hence, the cardiovascular risk (Maza Cave et al. 2000).

*Hypercholesterolemia* is a type of *hyperlipidemia*, ie, high levels of blood lipids, including triglycerides, cholesterol, and lipoproteins that make possible the cholesterol transport in blood plasma. Cholesterol-lipoprotein complexes with very low, low, and intermediate densities are named *pro-atherogenic cholesterol* and are cardiovascular risk factors. In contrast, cholesterol-lipoprotein complex with high density is named *anti-atherogenic cholesterol* and has protective effect on cardiovascular disease (Deng 2009). The *hypolipidemic* agents reduce the risk of cardiovascular diseases by lowering total cholesterol, pro-atherogenic cholesterol, and triglycerides levels (García Mesa 2014).

Hyperlipidemia and hypolipidemia (its opposite) are types of dyslipidemias. The generic term *dyslipidemia* refers to alterations in the synthesis, transport or metabolism of lipids, which modify the plasma concentrations of total cholesterol, transporter lipoproteins, and triglycerides (Furgione et al. 2009; García Mesa 2014). *Primary dyslipidemia* is due to genetic factors, and *secondary dyslipidemia* is due to environmental factors (diet, sedentary lifestyle) or pathologies such as obesity, diabetes, metabolic syndrome, among others (Maza Cave et al. 2000; Alegría Ezquerro et al. 2008).

The aim of this contribution is to present 82 species of medicinal vascular plants whose products are commercialized and consumed as cholesterol-lowering inside the Buenos Aires-La Plata conurbation. Also, regarding to the methodological proposal of the research line, show that hypocholesterolemic plant products illustrate the dynamics of urban BK, starting from the dissemination of the different products in the local commercial circuits.

## MATERIALS AND METHODS

The study area corresponds to the Buenos Aires-La Plata conurbation, which comprises two contiguous urban agglomerates: *Greater Buenos Aires* and *Greater La Plata*. The first includes the Ciudad Autónoma de Buenos Aires, the capital of Argentina, and the neighboring districts of the Buenos Aires province. According to the national census of 2010, the Greater Buenos Aires had about 13,000,000 inhabitants in 3850 square kilometers. In Buenos Aires city live 3,000,000 people at only 203 square kilometers. This widespread urban agglomerate is the largest metropolitan area in size and population of the country, the second in South America, the third in Latin America, the fifth in America and the seventeenth in the world.

Greater La Plata includes the city of La Plata, the capital of Buenos Aires province, located in the homonymous district, and the neighboring districts of Ensenada and Berisso. According to the above mentioned census this urban agglomerate had about 800,000 inhabitants in 1150 square kilometers. The conurbation has a total area of 5,000 square kilometers, in which live about 13,800,000 inhabitants (Puentes and Hurrell 2015).

The research methodological approach is strictly qualitative, based on usual ethnobotanical techniques: participant observation, free listings, free and semi-structured interviews, applied according to the specific comments and suggestions of different authors (Martin 1995; Blanco-Castro 1996; Quinlan 2005; Stepp 2005; Etkin and Ticktin 2010; Albuquerque et al. 2014). In particular, semi-structured interview questions were focused to identify the hypocholesterolemic use of plant products, and other related, as well as its diffusion level.

Data collection is performed without interruption since 2005, in 150 of outlets: 115 shops of the general commercial circuit (dietéticas, herbal stores) and 35 outlets of the restricted circuits of two groups of immigrants: Chinese and Bolivian, in the

Ciudad Autónoma de Buenos Aires. For the Chinese segment was relieved five supermarkets of the called *Barrio Chino*, a sector of Belgrano neighborhood, that sell products of the Traditional Chinese Herbal Medicine, imported from China (Hurrell and Pochettino 2014). For the Bolivian segment was relieved 30 outlets, the total shops and stalls that conform the *Bolivian market* in Liniers neighborhood, an example of traditional market nestled in an urban context (Pochettino et al. 2012; Puentes and Hurrell 2015). The selection of outlets of general commercial circuit started randomly and stopped upon reaching saturation of information about the products surveyed.

Two informants for each outlet were selected, so 300 people were interviewed previous informed consent. About 80% of those interviewed are sellers of both sexes and different ages, who know the properties and benefits of the products that they sell, and guide the consumers on their forms of employment and administration. The informants of the Chinese and Bolivian immigrants segments are mostly originally from their respective countries. The informants of the general commercial circuit are Argentine.

Samples of the products of each species were obtained in all outlets. Each sample was designated with an alphanumeric code and was deposited in the ethnobotanical collections of the LEBA. Commercial products – fragmented plant material, tinctures, dietary supplements (tablets, capsules), among others – indicate their components in their respective labels. However, materials not labeled, or with doubts about its composition, were identified by morphological characters and micrographic analysis (Vignale and Gurni 2007).

The medicinal species surveyed respond to the locally assigned use: “cholesterol-lowering” or “hypocholesterolemic” obtained from the interviews, data labels, prospectus and leaflets of each product, and the information disseminated in graphic media and the Internet. All data were confronted with the available ethnobotanical literature.

The *locally assigned use* is constructed from the urban BK (linked to traditions and non-traditional), and from changes of meaning that happen in the dynamics of the transmission of local BK (Hurrell 2014).

Also, a bibliographic review about diverse academic studies of effects and biological activity of each species was accomplished. These studies validate the locally assigned use in the scientific context. Certainly, each species has other medicinal uses, in some cases numerous, but have been omitted for reasons of space. Regarding academic studies analyzed was selected the hypocholesterolemic effect as well as others linked effects, as hypolipidemic, anti-dyslipidemic, anti-atherogenic.

The cholesterol-lowering effect can be obtained from an appropriate diet, which includes certain food plants such as soybeans, *Glycine max* (L.) Merr. (Mateos-Aparicio et al. 2008), chickpeas, *Cicer arietinum* L. (Jukanti et al. 2012), onions, *Allium cepa* L. (García Mesa 2014), among others. The hypocholesterolemic food plants were not considered in this contribution, which only includes plant species selected and consumed for medicinal purposes. However, there are products of species clearly identified as foods such as leaves and roots of chicory, *Cichorium intybus* L., or fruits of mango, *Mangifera indica* L., that were included because they have another products that are consumed as therapeutics: fragmented aerial parts of chicory, fragmented leaves of mango. In this sense it is important to highlight that the

selection of the species in this study also relies on the plant products circulating in the commercial circuit marketed for medicinal purposes.

Moreover, several species of aromatic plants were included because are used as therapeutics and at the same time as food condiments and/or beverages flavoring. In all the cases, the aromatic species treated here were identified as therapeutics in the interviews, eg, products of ginger, *Zingiber officinale* Roscoe, and turmeric, *Curcuma longa* L. (fragmented and powdered rhizomes), but products of cumin, *Cuminum cyminum* L. (mericarps) and rosemary, *Rosmarinus officinalis* L. (fragmented leaves), among others, were excluded because are only considered as condiment, despite that their hypocholesterolemic effect has been investigated (Andallu and Ramya 2007; Afonso et al. 2013).

## RESULTS

Table 1 includes the results obtained for the 82 species surveyed: scientific names, families, vernacular names, different types of products, samples, and references about biological activity and effects studied. The exclusive plant products from Bolivian market are indicated with an asterisk (\*), and the exclusive products from supermarkets in Barrio Chino are indicated with two asterisks (\*\*). Products without asterisk belong to general commercial circuit. The products sold correspond to dried materials (or derivatives like tinctures, solid or liquid extracts) except those indicated as *fresh* (eg, fresh plants, fresh fruits).

**Table 1.** Medicinal plants with cholesterol-lowering effect commercialized in the Buenos Aires-La Plata conurbation, Argentina.

Species, families, local names	Products types [Samples]	Biological activity and effects studied
<i>Achillea millefolium</i> L. Asteraceae Milenrama, aquilea	Fragmented aerial parts [C001] Tincture [H348]	Hypocholesterolemic, hypolipidemic (Mustafa et al. 2012; Hurrell and Puentes 2013).
<i>Achyrocline satureioides</i> (Lam.) DC. Asteraceae Marcela	Fragmented aerial parts [H097]*[H448] Herbal tea in bags (mixture) [H412] Tincture [H345]	Hypocholesterolemic, hypolipidemic (Espiña et al. 2012).
<i>Acorus calamus</i> L. Acoraceae Cálamo aromático	Fragmented rhizomes [P173]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic (Parab and Menghi 2002; Divya et al. 2011; Shafi and Tabassum 2013).
<i>Allium ampeloprasum</i> L. Amaryllidaceae Ajo macho	Bulbs [P255]*[F013] [P294]	Hypocholesterolemic, hypolipidemic (Roghani and Aghaie 2007; Dey and Khaled 2013; Puentes & Hurrell 2015).
<i>Allium sativum</i> L. Amaryllidaceae Ajo	Tablets [H329]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Bordia et al. 1998; Koscielny et al. 1999; García Mesa 2014).
<i>Aloysia citriodora</i> Palau Verbenaceae Cedrón	Fragmented leaves [C009] Herbal tea in bags [H044] Herbal tea in bags (mixture) [H047]	No data.
<i>Alpinia officinarum</i> Hance Zingiberaceae Galanga	Fragmented rhizomes [P176] Powdered rhizomes [C120]	Hypocholesterolemic, hypolipidemic, anti-lipogenic (Shin et al. 2003; Xia et al. 2010; Jung et al. 2012).
<i>Amorphophallus konjac</i> K. Koch Araceae Konjac	Tablets [SD29] [SD32]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Chen et al. 2003b; Vasques et al. 2008; Yanai et al. 2015).
<i>Angelica archangelica</i> L. Apiaceae Angélica	Fragmented roots [C006]	Hypocholesterolemic, hypolipidemic (Alabi et al. 2013).
<i>Angelica sinensis</i> (Oliver) Diels Apiaceae Angélica china	Fragmented roots [H399]**	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Li et al. 2000; Wu and Hsieh 2011; Wang et al. 2015).
<i>Artemisia absinthium</i> L. Asteraceae Ajenjo	Fresh plants [H165]* Fragmented aerial parts [H451] Tincture [H356]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Alabi et al. 2013; Daradka et al. 2014).
<i>Aspidosperma quebracho-blanco</i> Schlttl. Apocynaceae Quebracho	Fragmented bark [H219]	No data.
<i>Astragalus mongholicus</i> Bunge [= <i>A. membranaceus</i> Bunge] Leguminosae Astrágalo	Roots [H400]** Fragmented roots [P183] Capsules (mixture) [H323]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Li et al. 2000; Ma et al. 2011; Wang et al. 2012).



Species, families, local names	Products types [Samples]	Biological activity and effects studied
<i>Atractylodes lancea</i> (Thunb.) DC. [= <i>Atractylis ovata</i> Thunb.] Asteraceae Cang zhu	Fragmented rhizomes [H446]**	Hypolipidemic (Han et al. 2009).
<i>Baccharis articulata</i> (Lam.) Pers. Asteraceae Carqueja	Fresh plants [B416]* Fragmented aerial parts [P143]* [H449] Herbal tea in bags [H411] Tincture [H346] Tablets (mixture) [H501]	No data.
<i>Baccharis trímera</i> (Less.) DC. ASTERACEAE Carqueja	Fresh plants [B424]* Fragmented aerial parts [C017]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic (Pizziolo et al. 2011; Souza et al. 2011, 2012).
<i>Bauhinia forficata</i> Link subsp. <i>pruinosa</i> (Vogel) Fortunato & Wunderlin Leguminosae Pata de vaca	Fragmented leaves [H015] [H049]	Hypocholesterolemic, hypolipidemic (Lino et al. 2004; Barboza et al. 2009; Pizziolo et al. 2011).
<i>Bixa orellana</i> L. Bixaceae Achiote, urucú	Seeds [H398]* [H283]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Paula et al. 2009; Ferreira et al. 2013; García Mesa 2014).
<i>Calendula officinalis</i> L. Asteraceae Caléndula	Inflorescences [H200] Tincture [H341]	Hipocolesterolémico, hipolipidémico, anti-atherogenic (Lastra Valdés and Piquet García 1999; Liu and Guo 2010; Orekhov 2013).
<i>Cassia fistula</i> L. Leguminosae Cañafistula	Legumes [H228]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic (El-Saadany et al. 1991; Nirmala et al. 2008; Singh et al. 2010).
<i>Celidonium majus</i> L. Papaveraceae Celidonia	Fragmented aerial parts [H120] [H179]	Hipocolesterolémico, hipolipidémico (Zarei et al. 2014).
<i>Centella asiatica</i> (L.) Urb. Apiaceae Centella	Fragmented aerial parts [H076]* Tincture [H321] Tablets [H403] Tablets (mixture) [H404] Capsules [H380] Capsules (mixture) [H405]	Hipocolesterolémico, hipolipidémico, lipid modulator (Pingale 2008; Hussin et al. 2009; Chauhan et al. 2010).
<i>Cichoriun intybus</i> L. Asteraceae Achicoria	Fragmented aerial parts [H129]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic (Kocsis et al. 2003; Shafi and Tabassum 2013).
<i>Cola nítida</i> (Vent.) Schott & Endl. Malvaceae Cola, nuez de cola	Tincture [H295]	Hypocholesterolemic, hypolipidemic (Nku et al. 2014; Dah-Nouvlessounon et al. 2015).
<i>Crataegus laevigata</i> (Poir.) DC. Rosaceae Crataegus	Fragmented leaves [H153]	Hypocholesterolemic, hypolipidemic (Dalli et al. 2011; Robert et al. 2012; Littleton et al. 2013).
<i>Curcuma longa</i> L. Zingiberaceae Cúrcuma	Fragmented rhizomes [C136] Powdered rhizomes [C036]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Mesa et al. 2000; Megraj et al. 2011; Ibrahim et al. 2013; Saravanan and Ignacimuthu 2015).

Species, families, local names	Products types [Samples]	Biological activity and effects studied
<i>Cymbopogon citratus</i> (DC.) Stapf Poaceae Pasto limón	Fresh tillers [FB407]* [RF08] Fragmented tillers [H171]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherogenic (Orrego et al. 2009; Bidkar et al. 2011; Costa et al. 2011; Souza et al. 2012; Ekpenyong et al. 2014).
<i>Cynara cardunculus</i> L. [= <i>C. scolymus</i> L.] Asteraceae Alcachofa	Fragmented leaves [H069] Tincture [H333] Herbal tea in bags [H093]* [H411] Tablets [H094]* Tablets (mixture) [H501]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Brown and Rice-Evans 1998; Souza et al. 2012; Ibrahim et al. 2013; Wider et al. 2013; Falé et al. 2014).
<i>Eucommia ulmoides</i> Oliv. Eucommiaceae Du zhong	Fragmented bark [H447]**	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Yen and Hsieh 1998; Choi et al. 2008; He et al. 2014).
<i>Eugenia uniflora</i> L. Myrtaceae Pitanga	Fragmented leaves [H140]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic (Bongiolo 2008; Barboza et al. 2009; Pizziolo et al. 2011).
<i>Euterpe oleracea</i> Mart. Arecaceae Açaí	Capsules [H302] [H500]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Devalaraja et al. 2011; Souza et al. 2010, 2012).
<i>Foeniculum vulgare</i> Mill. Apiaceae Hinojo	Mericarps [C047] Powdered mericarps [C121] Tincture [H274]	Hypocholesterolemic, hypolipidemic, anti-atherogenic (Badgujar et al. 2014; Oulmouden et al. 2014).
<i>Garcinia gummi-gutta</i> Roxb. [= <i>G. cambogia</i> (Gaertn.) Desr.] Clusiaceae Garcinia	Fruits [H305]** Tincture [H303] Tablets [H318] [SD41] Capsules (mixture) [H405]	Hypocholesterolemic, hypolipidemic, anti-lipogenic, anti-atherogenic (Koshy et al. 2001; Vasques et al. 2008; Bidkar et al. 2011; Ateş et al. 2012; Semwal et al. 2015).
<i>Gentianella alborosea</i> (Gilg.) Fabris Gentianaceae Hercampuri	Fragmented aerial parts [P155] Capsules [H377] [P277]	Hypolipidemic (Li et al. 2010; Puentes and Hurrell 2015).
<i>Ginkgo biloba</i> L. Ginkgoaceae Ginkgo	Fragmented leaves [H052] Tablets [H111] [H327] Capsules (mixture) [H323]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Yao et al. 2007; Xie et al. 2009; Wei et al. 2013).
<i>Glycyrrhiza glabra</i> L. Leguminosae Regaliz	Fragmented roots [H050] Powdered roots [H035] Herbal tea in bags (mixture) [H046] Capsules (mixture) [H323]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Asgary et al. 2007; Maurya et al. 2009; Megraj et al. 2011; Dhaliya et al. 2013; Saravanan and Ignacimuthu 2015).
<i>Handroanthus impetiginosus</i> (Mart. ex DC.) Mattos [= <i>Tabebuia impetiginosa</i> (Mart. ex DC.) Standl.] Bignoniaceae Lapacho	Fragmented bark [H207]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Pizziolo et al. 2011; Kiage-Mokua et al. 2012; Choi et al. 2014).
<i>Heimia salicifolia</i> (Kunth) Link Lythraceae Quiebra arado	Fragmented aerial parts [H124]	No data.
<i>Hibiscus sabdariffa</i> L. Malvaceae Rosella, Mei gui qie	Fragmented calyxes [P235]**	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic, anti-lipogenic (Chen et al. 2003a; Yang et al. 2010; Ibrahim et al. 2013; García Mesa 2014).

Species, families, local names	Products types [Samples]	Biological activity and effects studied
<i>Hypericum perforatum</i> L. Hypericaceae Hypericón	Fragmented aerial parts [H010] [H119]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherogenic (Zou et al. 2005; Ineedi and Kumar 2009; Husain et al. 2011; Asgary et al. 2012).
<i>Jodina rhombifolia</i> (Hook. & Arn.) Reissek Santalaceae Sombra de toro	Fragmented leaves [H149]	No data.
<i>Lepidium meyenii</i> Walp. Brassicaceae Maca	Fragmented underground organs [H008] Powdered underground organs [H160]* [P271]* [H036] Tincture [H297] Capsules [P278]* [H178]	Hypocholesterolemic, hypolipidemic, anti-atherogenic (Vecera et al. 2007; Oré Sifuentes 2008; Puentes and Hurrell 2015).
<i>Linum usitatissimum</i> L. Linaceae Lino	Seeds [H061] [H104] Powdered seeds [H106] [H316]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Cunnane et al. 1993; Muir et al. 1999; Tomaz Pacheco et al. 2011; Saravanan and Ignacimuthu 2015).
<i>Lupinus albus</i> L. Leguminosae Lupino	Tablets [H308]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Viveros et al. 2007; Marchesi et al. 2008; Sewani-Rusike et al. 2015).
<i>Lycium barbarum</i> L. Solanaceae Goji	Fruits [D001]** [H037]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Luo et al. 2004; Bidkar et al. 2011; Jiang 2011; Hurrell et al. 2013; Shafi and Tabassum 2013).
<i>Mangifera indica</i> L. Anacardiaceae Mango	Fragmented leaves [H427]	Hypocholesterolemic, hypolipidemic, anti-atherogenic (Muruganandan et al. 2005; Hossain et al. 2010).
<i>Marrubium vulgare</i> L. Lamiaceae Marrubio	Fragmented aerial parts [C094]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic (Roghani et al. 2005; Shafi and Tabassum 2013; Elberry et al. 2015).
<i>Matricaria chamomilla</i> L. [= <i>M. recutita</i> L.] Asteraceae Manzanilla	Fresh plants [B427]* Fragmented aerial parts [H089] Herbal tea in bags [H016] Tincture [H357]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic (McKay and Blumberg 2006; Al-Bayati 2012; Al-Musa and Al-Hashem 2014; Raftaf et al. 2015).
<i>Medicago sativa</i> L. Leguminosae Alfalfa	Fragmented aerial parts [H086] Herbal tea in bags (mixture) [H046] [H411] Tablets [H309] Liquid extract [H310]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Khaleel et al. 2005; Bidkar et al. 2011; Shi et al. 2014; Zhou et al. 2014).
<i>Melissa officinalis</i> L. Lamiaceae Melisa, toronjil	Fragmented aerial parts [C014] Tincture [H320]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic (Karimi et al. 2010; Weidner et al. 2014; Zarei et al. 2015).
<i>Mentha × piperita</i> L. Lamiaceae Menta piperita, menta	Fragmented aerial parts [C124] Herbal tea in bags [H028] Herbal teain bags (mixture) [H065]	Hypocholesterolemic, hypolipidemic (Mani Badal et al. 2011; Johari et al. 2015).



Species, families, local names	Products types [Samples]	Biological activity and effects studied
<i>Morinda citrifolia</i> L. Rubiaceae Noni	Fresh fruits [P218]* Powdered fruits [H161]* [RF80] Capsules [H162]* [H379] Liquid extract [PN03]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Kamiya et al. 2004; Mandukhail et al. 2010; Nayak et al. 2011; Lin et al. 2012; Lee et al. 2012).
<i>Moringa oleifera</i> Lam. Moringaceae Moringa	Fragmented leaves [H432]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Ghasi et al. 2000; Chumark et al. 2008; Mbikay 2012; Dhaliya et al. 2013).
<i>Myrciaria dubia</i> (Kunth) McVaugh Myrtaceae Camu-camu	Capsules [H602]	Hypocholesterolemic, hypolipidemic (Nascimento et al. 2013; Langley et al. 2015).
<i>Olea europaea</i> L. Oleaceae Olivo	Leaves [H191]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Miranda Velásquez 2010; Susalit et al. 2011).
<i>Panax ginseng</i> C. A. Mey. Araliaceae Ginseng	Fragmented roots [H114] Herbal tea in bags (mixture) [H046] Tablets [H319] Capsules (mixture) [H323]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Yamamoto et al. 1983; Lee et al. 2013; Kawase et al. 2014).
<i>Paullinia cupana</i> Kunth Sapindaceae Guaraná	Seeds [H258] Tablets [H311]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Pizzolo et al. 2011; Lima Portella et al. 2013).
<i>Peumus boldus</i> Molina Monimiaceae Boldo	Fragmented leaves [C010] Herbal tea in bags [H017] Herbal tea in bags (mixture) [H047] [H412] Tablets (mixture) [H501]	Hypocholesterolemic, anti-atherosclerotic (Santanam et al. 2004; Falé et al. 2014).
<i>Phyllanthus niruri</i> L. Euphorbiaceae Chancapiedra	Fragmented aerial parts [P195]* [P205] Capsules [H441]* [H447]	Hypocholesterolemic, hypolipidemic (Khanna et al. 2002; Barboza et al. 2009; Megraj et al. 2011).
<i>Plantago major</i> L. Plantaginaceae Llantén	Fragmented leaves [H208]	Hypocholesterolemic, anti-atherogenic (Angarskaya and Sokolova 1963; García-Lazo et al. 2015).
<i>Plantago ovata</i> Forssk. Plantaginaceae Psyllium	Seeds [H393]** Powdered seeds [H325]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic (Wärnberg et al. 2009; Solàet al. 2007, 2010).
<i>Plukenetia volubilis</i> L. Euphorbiaceae Sacha inchi	Seeds [D005] Powdered seeds [P249]* Capsules (extract) [D003] Capsules (oil) [H301]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Garmendia et al. 2011; Hurrell et al. 2013; Puentes and Hurrell 2015).
<i>Polygonum aviculare</i> L. Polygonaceae Sanguinaria	Fragmented aerial parts [H197]	Hypocholesterolemic, hypolipidemic, anti-lipogenic, anti-atherosclerotic (Sung et al. 2013; Park et al. 2014).
<i>Psidium guajava</i> L. Myrtaceae Arazá	Fragmented leaves [H260]	Hypocholesterolemic, hypolipidemic (Deguchi and Miyazaki 2010; Dhaliya et al. 2013; Puentes and Hurrell 2015).
<i>Rehmannia glutinosa</i> (Gaertn.) DC. Orobanchaceae Gan di huang	Fragmented roots [H448]**	Hypocholesterolemic, hypolipidemic (Poon et al. 2011; Zhou et al. 2015).

Species, families, local names	Products types [Samples]	Biological activity and effects studied
<i>Rheum officinale</i> Baill. Polygonaceae Ruibarbo	Fragmented rhizomes [H216] [H435]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Nada et al. 1997; Gao et al. 2010; Zhong et al. 2012).
<i>Salvia hispanica</i> L. Lamiaceae Chía	Seeds [H042] [H113] Powdered seeds [H107] [H313]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Vázquez-Ovando et al. 2009; Ali et al. 2012; Sierra et al. 2015).
<i>Salvia officinalis</i> L. Lamiaceae Salvia	Fragmented leaves [C015]	Hypocholesterolemic, hypolipidemic (Ibrahim et al. 2013; García Mesa 2014).
<i>Satureja hortensis</i> L. Lamiaceae Ajedrea	Fragmented leaves [C028] [H070]	Hypocholesterolemic, hypolipidemic (Mchedlishvili et al. 2005; Momtaz and Abdollahi 2008).
<i>Schisandra chinensis</i> (Turcz.) Baill. Schisandraceae Eschisandra	Fruits [RF59]** [P208] Capsules (mixture) [H323]	Hypocholesterolemic (Panossian and Wikman 2008; Pan et al. 2012).
<i>Silybum marianum</i> (L.) Gaertn. Asteraceae Cardo mariano	Seeds [H154] Capsules [H354]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Krecman et al. 1998; Huseini et al. 2006; Radjabian et al. 2010; Derosa et al. 2013; Hurrell and Puentes 2013).
<i>Smallanthus sonchifolius</i> (Poepp. & Endl.) H. Rob. Asteraceae Yacón	Fresh roots [H6891]* Fragmented leaves [H332] Tincture [H285] Capsules [H286] [H293] Liquid extract [P275]	Hypocholesterolemic, hypolipidemic (Miura et al. 2004; Valencia 2005; Habib et al. 2011; Hurrell et al. 2013; Puentes and Hurrell 2015).
<i>Stevia rebaudiana</i> (Bertoni) Bertoni Asteraceae Yerba dulce	Fresh plants [B415]* Fragmented leaves [H198] Tincture [H350] Powdered extract [H116] Liquid extract [H317]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Savita et al. 2004; Geeraert et al. 2010; Hossain et al. 2011; Singh and Garg 2014).
<i>Taraxacum officinale</i> Weber ex F.H. Wigg. Asteraceae Diente de león, amargón	Fragmented aerial parts [H100]* [C087] Tincture [H337]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Choi et al. 2010; Alabi et al. 2013; Hurrell and Puentes 2013).
<i>Tessaria integrifolia</i> Ruiz & Pav. Asteraceae Pájaro bobo	Fragmented aerial parts [H227] [H335] Tincture [H340]	No data.
<i>Trigonella foenum-graecum</i> L. Leguminosae Fenogreco	Seeds [H452] Powdered seeds [H062]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherogenic (Nada et al. 1997; Ibrahim et al. 2013; Kumar and Bhandari 2013; Yadav and Baquer 2014).
<i>Trixis divaricata</i> (Kunth) Spreng. [= <i>T. antimenorrhoea</i> (Schränk) Mart. ex Kuntze] Asteraceae Contrayerba	Fragmented aerial parts [P146]	Hypocholesterolemic (Granato et al. 2013).
<i>Uncaria tomentosa</i> (Willd.) DC. Rubiaceae Uña de gato	Bark (chunks) [H109] Bark (splinters) [H110] Tincture [H273] Capsules [H378]	Hypocholesterolemic, anti-atherosclerotic (Potawale et al. 2008; Pizziolo et al. 2011).

Species, families, local names	Products types [Samples]	Biological activity and effects studied
<i>Vaccinium corymbosum</i> L. Aiton Ericaceae Arándano, arándano azul	Fragmented leaves [H029] Tablets [H407]	Hypocholesterolemic, hypolipidemic, anti-atherogenic (Kim et al. 2010; Çoban et al. 2013; Liang et al. 2013).
<i>Vaccinium macrocarpon</i> Aiton Ericaceae Arándano rojo	Tablets [H406]	Hypocholesterolemic, hypolipidemic, anti-atherosclerotic (Shabrova et al. 2011; Anhê et al. 2015).
<i>Xanthium spinosum</i> L. Asteraceae Cepa caballo, abrojo	Fragmented aerial parts [H127] Tincture [H344]	No data.
<i>Zingiber officinale</i> Roscoe Zingiberaceae Jengibre	Fragmented rhizomes [H453] Powdered rhizomes [H454] Capsules (mixture) [P170]	Hypocholesterolemic, hypolipidemic, anti-dyslipidemic, anti-atherosclerotic (Verma et al. 2004; Bhandari et al. 2005; Megraj et al. 2011; Bidkar et al. 2011; Ibrahim et al. 2013; García Mesa 2014).

Of the 82 species surveyed, 23 (28%) are aromatic species consumed both as therapeutics and food condiment and/or beverages flavoring: *Achillea millefolium*, *Achyrocline satureioides*, *Acorus calamus*, *Allium sativum*, *Aloysia citriodora*, *Alpinia officinarum*, *Angelica archangelica*, *Artemisia absinthium*, *Baccharis articulata*, *B. trimera*, *Bixa Orellana*, *Curcuma longa*, *Cymbopogon citratus*, *Foeniculum vulgare*, *Marrubium vulgare*, *Matricaria chamomilla*, *Melissa officinalis*, *Mentha x piperita*, *Peumus boldus*, *Salvia officinalis*, *Satureja hortensis*, *Trigonella foenum-graecum*, and *Zingiber officinale*.

Only 7 species (8.5%) have no academic studies that validate their hypocholesterolemic effect. These species are: *Aloysia citriodora*, *Aspidosperma quebracho-blanco*, *Baccharis articulata*, *Heimia salicifolia*, *Jodina rhombifolia*, *Tessaria integrifolia*, and *Xanthium spinosum*. It would be desirable to encourage future validation studies for these species.

Products of 10 species (12.2% of total) are related to the Chinese immigrants segment. Half of these species are commercialized only in the Barrio Chino: *Angelica sinensis*, *Atractylodes lancea*, *Eucommia ulmoides*, *Hibiscus sabdariffa*, and *Rehmannia glutinosa*. The remaining five species have products sold in the restricted circuit of the Barrio Chino, but also have products that are marketed in the general commercial circuit: *Astragalus mongholicus*, *Garcinia gummi-gutta*,

*Lycium barbarum*, *Plantago ovata*, and *Schisandra chinensis*.

Products belonging to 17 species (20.8% of total) are sold in the Bolivian market of Liniers: *Achyrocline satureioides*, *Allium ampeloprasum*, *Artemisia absinthium*, *Baccharis articulata*, *B. trimera*, *Bixa orellana*, *Centella asiatica*, *Cymbopogon citratus*, *Cynara cardunculus*, *Lepidium meyenii*, *Matricaria chamomilla*, *Morinda citrifolia*, *Phyllanthus niruri*, *Plukenetia volubilis*, *Smallanthus sonchifolius*, *Stevia rebaudiana*, and *Taraxacum officinale*. All these species are also represented through different products in the general commercial circuit.

Of the total of 82 species surveyed, 55 species (67%) have products that are marketed only in the general commercial circuit.

## DISCUSSION AND CONCLUSIONS

The theoretical and methodological basis of the research line assumes that: 1) the local BK orients the strategies of selection and use of plant products; 2) these strategies are evident in the circulation of those products within local commercial circuits; 3) since there is no direct access to the BK, its reconstruction is possible starting from the assessment of the circulation of those plant products. As noted above, plant products circulating only inside the restricted

commercial circuit of the immigrant segments are considered *invisible* to most of the urban population. On the other hand, plant products circulating inside the general commercial circuit are considered *visible* to all urban inhabitants. In this context, invisible plant products are related to the BK *linked to traditions*, and visible plant products are related to the *non traditional* BK. The dynamics of urban BK is expressed through the passage of plant products from the restricted circuit of immigrants towards general commercial circuit, so those products acquire *visibility*. That 'passage' of plant products involves a contextual change that we call *visualization process*. This process implies the transmission of BK that is expressed in the diffusion of the products, mainly performed by the mass media and specialized stores as the dietéticas. The evaluation of the results of this contribution on the medicinal plants used as hypocholesterolemic allows us to illustrate the dynamics of the local BK.

With regard to the Chinese immigrants segment, plant products of five species are exclusive of this restricted commercial circuit, therefore, these species are *invisible*. Other five species have products sold in the restricted circuit of the Barrio Chino, but also have products that are marketed in the general commercial circuit. In these cases, particular products remain *invisible*, but the species are *visible* because other plant products are marketed in the general commercial circuit. Dried roots of *Astragalus mongholicus*, dried fruits of *Garcinia gummi-gutta*, and seeds of *Plantago ovata* are exclusive (*invisible*) products of the Chinese segment. Fragmented roots and capsules of *A. mongholicus*, tincture, tablets and capsules of *G. gummi-gutta*, and powdered seeds of *P. ovata* are products marketed in the general commercial circuit (*visible*). Dried fruits of *Lycium barbarum* and *Schisandra chinensis* are present both in general and restricted circuits. Should be noted that products represented in the general circuit are mostly processed, and therefore more adequate for the urban lifestyle, because are *easier to consume*. Through the products, the species acquire visibility, and enter the context of the *non-traditional* BK. The products diffusion can be a quick process, enhanced by the media, as was

previously indicated for *L. barbarum* (Hurrell et al. 2013). Moreover, the widest variety of products of *G. gummi-gutta* is evidence of a wider diffusion and, at the same time, a major permanence in the general commercial circuit.

For the segment of Bolivian immigrants, the 17 species marketed in the Bolivian market of Liniers are also sold in the general commercial circuit, but through different products. In this sense, it is important to highlight that although the species are visible, their particular products can be visible or invisible. For instance, from the standpoint of particular products, fresh plants of *Artemisia absinthium*, *Baccharis articulata*, *B. trimera*, *Matricaria chamomilla*, and *Stevia rebaudiana*, fresh fruits of *Morinda citrifolia*, fresh roots of *Smallanthus sonchifolius*, powdered seeds of *Plukenetia volubilis*, and fragmented aerial parts of *Centella asiatica*, are exclusive of the Bolivian market, thus, are *invisible*. As in the case of the Chinese immigrants segment, products disseminated in the general circuit that were introduced from the segment Bolivian immigrants mostly correspond to tinctures, tablets, capsules, extracts, ie, products *easy to consume*, preferred by urban inhabitants. The Bolivian market of Liniers constitutes a source of diverse plant products that enrich local urban diversity, both products as their related BK (Pochettino et al. 2012). In the last decade, the research line of the LEBA has studied the entry of several plant products into the Bolivian market of Liniers coming from Peru and Bolivia. Thereafter, these products have entered into the general commercial circuit of the study area, so the species became visible. Such is the case of *Lepidium meyenii* and *M. citrifolia* (Arenas et al. 2011), *P. volubilis* and *S. sonchifolius* (Hurrell et al. 2013), and *Allium ampeloprasum* (Puentes and Hurrell 2015). Except *A. ampeloprasum*, with only one product recently disseminated and at present under expansion, the other species have diverse products, and their diffusion is wider and their permanence time is longer in local general commercial circuit.

Regarding to general commercial circuit, 55 species used as hypocholesterolemic are only presented in this context related to the *non-traditional* urban BK. Thus, are *visible* with greater

or lesser level of diffusion. Some of these species, like *Aloysia citriodora*, *Aspidosperma quebracho-blanco*, *Handroanthus impetiginosus*, *Jodina rhombifolia*, and *Plantago major*, have their roots in the popular medicine of Argentina, which favors its diffusion in the commercial circuit. Other species such as *Ginkgo biloba*, *Glycyrrhiza glabra*, *Panax ginseng* and *Uncaria tomentosa* have wide circulation as dietary supplements. They are products easy to consume, fact that increases their chances of diffusion. Others species have recently been introduced into the local urban scenario, like *Euterpe oleracea*, whose products have more poor dissemination (Hurrell et al. 2013).

In summary, of the cholesterol-lowering 82 treated species, 77 (93.9%) are *visible*, including 55 species marketed only in the general commercial circuit, 17 species of the Bolivian market and 5 species of the Barrio Chino that are also represented in that circuit. Only 5 species (6.1%) of the Chinese immigrants segment are *invisible*. It is possible that these species acquire visibility in the future, if we assume that could enter the general commercial circuit, as happened recently with *Lycium barbarum* (Hurrell et al. 2013). In this framework, the restricted circuits of immigrants segments act as sources of species and their associated knowledge that increase the local biocultural diversity.

The interest of the urban population by the problematic of cholesterol, linked to the risk of cardiovascular disorders and diseases as diabetes and obesity is reflected in the high visibility of different species used as cholesterol-lowering and the variety of products available. A similar situation occurs with other categories of medicinal plants related to the lifestyle of large cities: slimming, antioxidants, adaptogens, cognitive enhancers, and aphrodisiacs (Arenas et al. 2011, 2015; Hurrell et al. 2013, 2015; Hurrell & Puentes, 2013; Hurrell 2014). In this context, this paper constitutes a new contribution in order to understand the complexity of the botanical knowledge dynamics for the study area.

Moreover, this paper also constitutes a contribution to the field of the ethnobotany of the multicultural urban contexts regarding with its theoretical-methodological framework. Because

the botanical knowledge (both non-traditional and linked to traditions) guides the strategies of selection and utilization of species and products, the analysis of circulating products constitute an adequate methodological tool to assess the characteristics of the local botanical knowledge and its transmission inside the multicultural urban contexts, in which the mass media are actively involved.

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